



# **Aquatic Plant Sampling Protocols**

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# Aquatic Plant Sampling Protocols

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# Abstract

Many different methods have been developed for assessing aquatic vegetation. This document describes those methods used by the Washington State Department of Ecology, Aquatic Plant Monitoring Program. It includes descriptions of inventorying waterbodies for invasive non-native species, mapping vegetation populations, and quantifying the plant community through line-intercept frequency, point-intercept frequency, and biomass data analysis. References are also supplied to provide additional details for each of these methods.

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# Introduction

## Purpose

The purpose of this document is to provide details on the aquatic plant sampling techniques used by the Department of Ecology's Aquatic Plant Technical Assistance Program. These methods range from the relatively simple to intensive and complex, and may be used as a guide for conducting aquatic plant monitoring. For additional methods not covered by this paper consult the documents listed in the reference section.

## Background and Program Objectives

Legislative action in 1991 (RCW 43-21A.660) established the Freshwater Aquatic Weed Account to provide expertise on aquatic plant issues and a source of grant money for local aquatic weed management projects. To provide technical expertise for aquatic plants, part of the Freshwater Aquatic Weed Account was used to create one full-time position within the Environmental Assessment Program of the Department of Ecology. One of the duties of this position is to conduct, aided by a summer field assistant, annual aquatic plant monitoring on Washington's lakes and rivers.

There are several goals for monitoring aquatic plants. The primary goal is to find new populations of invasive non-native aquatic and wetland plant species. Secondary goals include monitoring existing known invasive non-native plant populations for expansion or decline; maintaining a database of all native plant species present in the inventoried waterbodies; and monitoring the effects of weed treatment efforts. To attain these goals different sampling methods are employed based on the level of detail required.

# Sampling Methods

We use several methods of sampling waterbodies for aquatic plants based on the level of accuracy and detail required to satisfy the study objective (Table 1). These methods are described through the rest of the document organized by common study objectives.

Table 1: summary of aquatic plant monitoring methods covered in this paper.

Objective	Suggested Methods	Relative effort / cost	Data reliability
Find invasive species	Surface inventory	Low	Low
	Diver inventory	Medium	Medium
Create species list	Surface inventory	Low	Low
	Diver inventory	Medium	Medium
Detect population changes Over time/ assess infestations to determine appropriate control methods	Surface mapping	Medium	Low/medium
	Diver mapping	Medium	Medium
	Remote sensing	Medium	Medium
Evaluate effectiveness of control methods	Frequency data from transects or points	Medium	High
	Biomass	High	High

First, however, it should be noted that all methods are meaningless if the aquatic plants are misidentified (Hellquist 1993). Aquatic plant identification can be very difficult, at times requiring chemical or DNA analysis. Personnel with experience identifying aquatic plants should always conduct the studies. Appendix A contains a list of aquatic plant identification references we commonly use. We are also producing an aquatic plant field identification guide for Washington which should be completed in 2001. When a plant can not be identified with confidence it should be sent to an expert. The author may be contacted for suggestions on whom to send the plant.

It is also advisable to collect voucher specimens of each plant species so long as the plant is plentiful in the environment. Do not collect plants listed as rare by the Washington Natural Heritage Program (Washington Natural Heritage Program, 1997). Voucher specimens are most important when invasive non-native plants are concerned, and when repeated monitoring of the same waterbody will take place (Hellquist 1993; Newroth 1993). They provide a permanent record in case the identification is later questioned.

I would also like to emphasize the importance of monitoring aquatic plants using objective quantitative methods on lakes where aquatic plant control methods are being used. Good data collected in a scientifically sound manner are invaluable when assessing a control method's effectiveness. Money spent on monitoring ensures appropriate use of plant control methods.

The monitoring data will tell you what methods are working, and how well they are working (Madsen and Bloomfield 1993; Titus 1993).

## **Objective: Locate invasive non-native species**

Often lake front residents or local governments simply want to inventory a waterbody for invasive non-native species. Two methods are described here, both of which are relatively quick and easily accomplished.

### **Surface Inventory**

The surface inventory is the most rapid way to assess a waterbody, and can be accomplished with a minimum of equipment. However, it is also the least accurate. Submersed species in deeper water may be missed when looking only from the surface (Capers, 2000). If invasive non-native submersed species are found, they typically are in greater abundance than would appear from the surface. A subsequent inventory by divers is required to obtain an accurate assessment of the infestation.

#### **Required equipment**

- ◆ Boat capable of maneuvering in shallow, plant-filled water.
- ◆ Sampling rake (2 metal leaf rakes bolted back-to-back, handles removed and replaced with a rope. It is also helpful to bolt a thin metal plate between the rakes to add weight).
- ◆ Viewing tube (Can be purchased at diver supply stores, or make one with a section of 12-inch diameter PVC pipe and a clear Plexiglas circle glued over one end).
- ◆ Plastic bags to contain unidentified plants.
- ◆ Map of the waterbody and notepaper or data sheets, preferably on water-resistant paper such as Rite-in-the-Rain®.
- ◆ Global Positioning System (GPS) unit for marking plant locations.
- ◆ Plant press to collect specimens.

#### **Method**

The inventory is accomplished by slowly moving throughout the littoral zone looking through the water at the submersed species and along shore at the emergent species. In waterbodies with a broad littoral zone this is best accomplished by moving along the shoreline in a zigzag fashion so all water depths are observed. In shallow water the viewing tube can enhance visibility. When the water is too deep to allow plants to be observed directly, the sampling rake is thrown overboard periodically to bring plants up from the bottom. Extra care should be used in examining public access areas such as boat launches because these are frequently the areas where invasive species first appear.

Plants are identified in the field whenever possible. Reference books can be carried in the field, and notes or pages that are used frequently can be laminated to make them water resistant. Any possible invasive non-native species that can not be positively identified should be collected and

sent to an expert for confirmation. Contact the author for suggestions on whom to send specimens.

If invasive non-native species are found, the location is marked on the map and position data are recorded from the GPS. Collect a voucher specimen of the plant and preserve it using normal herbarium techniques (Appendix B). It is also important to notify local noxious weed control staff of the find if it is a newly discovered population.

### **Data analysis**

A list of invasive non-native plant species and map of their locations are the products, no technical data analysis is required. The voucher specimens will serve as a permanent record in case plant identities are later questioned.

## **Diver Inventory**

The diver inventory is usually more costly and time consuming than the surface inventory. However, if the divers are towed slowly with a boat or have underwater scooters, the process can be accelerated. The quality of the results is generally much higher than the surface inventory, so long as the divers know how to identify submersed plants and if they are methodical in their approach. This method is most effective in lakes with relatively good water clarity (3 meters or more).

If this method is being used to look for remnant invasive species after control work has been done, the inventory should be conducted several times throughout the growing season. This helps to minimize the number of plants escaping detection as they resprout (Newroth 1993).

### **Required equipment**

- ◆ SCUBA diving gear.
- ◆ Certified divers familiar with aquatic plant identification.
- ◆ Support boat and pilot.
- ◆ Plastic bags to contain unidentified plants.
- ◆ Maps and/or GPS unit for marking weed locations.
- ◆ Plant press to collect voucher specimens.

### **Method**

If the littoral zone is narrow, the divers may swim parallel to shore staying within sight of each other so that they can view the entire littoral zone. When they encounter invasive non-native species the support people on the boat mark the location on the map and record GPS coordinates. Underwater communication equipment greatly facilitates this procedure. A voucher specimen of the invasive species should be collected and preserved (Appendix B).

If the littoral zone is wide, the divers should swim lines perpendicular to shore from shallow to deep water and back again. The lines should be close enough so the entire substrate is inventoried. An underwater scooter and compass will save much time and energy.

### **Data analysis**

A list of found invasive non-native plant species and their locations are the products, no technical data analysis is required. The voucher specimens will serve as a permanent record in case plant identities are later questioned.

## **Objective: Make a list of species present in the waterbody**

A species list is a useful record to have for a waterbody, and is the type of data we routinely collect. It can be used to document changes in the plant community over time, which can be indicative of changes in lake productivity. It also can heighten awareness of aquatic plant species and issues if lake residents aid in the inventory. This will increase the likelihood that they will recognize invasive non-native plants if they are introduced.

Creating a list of all species observed in a waterbody does not require more equipment than inventorying the waterbody for invasive species as described above. It will require more time, as all habitats within the lake should be examined and additional time may be spent identifying unusual native species.

### **Required equipment**

See above lists for surface or diver inventories for invasive non-native plants.

### **Methods**

Methods are the same as for the surface or diver inventories for invasive non-native plants except the following:

- ◆ Personnel must be familiar with native as well as invasive non-native plant species.
- ◆ Different microhabitats within the waterbody and along shore must be sought. These small areas of unique habitat are most likely to host different native plant species.
- ◆ Collect voucher specimens of all but listed rare plants (Washington Natural Heritage Program 1997).
- ◆ If doing a surface survey, sample regularly with the rake to pick up species that may be growing beneath the dominant plants that are visible from the surface. Check frequently with the viewing tube if weather conditions are such that viewing plants through the water surface is difficult.
- ◆ Collect unidentified plants for later identification in the lab or by an expert if the plant is plentiful. If the plant is scarce in the waterbody, describe it or photograph it in the field and identify it later.
- ◆ Notes can be taken on things like species abundance, plant vigor, and growth stage. However, any subjective estimate of abundance should be substantiated with quantitative data if the information is to be used to make management decisions (Madsen and Bloomfield 1993).

## **Data Analysis**

The results will be a list of all species observed at the waterbody, including native and non-native plants. Optional results will be notes on the plant's distribution and abundance. These data can be used to monitor the plant community for changes in species composition over time, or to compare with other waterbodies in the region. The preserved voucher specimens will serve as a permanent record in case plant identities are later questioned.

*Caution:* The presence of a species is a definitive end point. However, absence of a species from a waterbody may mean that the plant was overlooked or was not growing at the time of the survey. If it is important to have a complete species list, a more systematic method of sampling should be used and repeated several times through the growing season (Madsen and Bloomfield 1993).

## **Objective: Monitor a plant population, mapping**

This method yields more detailed results that can be analyzed using computer mapping (GIS) technology. It is more time consuming than the above methods, but worth the effort if you want to track changes in plant community boundaries over time. The method described here covers both surface and diver inventories. As with all the methods, the people conducting the fieldwork must be able to identify the aquatic plants they are likely to encounter. Remote sensing methods are not covered in this paper, but references are provided to aid in researching this technique.

## **Surface or Diver Survey**

### **Required equipment**

- ◆ Detailed paper map of the waterbody, bathymetric maps are helpful.
- ◆ GPS equipment.
- ◆ Computer mapping software (GIS).
- ◆ Boat capable of maneuvering in shallow water.
- ◆ Viewing tube and sampling rake or snorkel or SCUBA diving gear.

### **Methods**

The timing of the survey can greatly influence the outcome. Ideally it should occur when the plants are at their peak biomass, usually in mid to late summer. However, if assessing an early infestation of an invasive non-native species, the inventory should occur as soon as possible so appropriate control methods can be started.

For vegetation easily seen from the water's surface such as emergent or floating species, the survey can be performed from a boat. Plant populations rarely end at easily defined boundaries, instead they tend to become less prevalent in a transition zone, then eventually disappear to be replaced by a different species or community. Therefore a definition of what will be considered the population boundary should be decided upon before mapping begins. If mapping one particular species, zones with a certain percent cover of that species can be marked. If mapping

all vegetation, areas with clearly dominant species can be mapped, and other areas can be mapped as transition zones. Notes should be kept on the less common species present.

The GPS unit is used to mark the boundaries. It is helpful to have a GPS unit that can store many location points in its memory, then the points can be downloaded directly into the computer for mapping. Estimates of percent cover of each plant being mapped can be made as you go.

Submersed vegetation mapping requires snorkelers or divers to determine the population boundaries. If conditions permit, personnel on the boat can follow the diver's bubbles at a safe distance and collect the GPS data. It is especially helpful to use radios to communicate with the boat operator. It is useful to create a rough paper map of the observations while in the field then refine it with the computer later. Another widely used method is to collect information along transects laid out perpendicular to shore. This method is more systematic and is easily duplicated if the mapping will be repeated as part of a monitoring program (Dubois et al 1984).

### Data Analysis

The GPS data is used to create a map of plant location boundaries with computer mapping software (Figure 1). The mapping program can generate values for the physical area occupied by the plant which can be compared over time as the inventory is repeated (Figure 2). It can also be used to analyze the relationship between macrophyte communities and other geographical features (Remillard and Welch 1993, Janauer 1997).

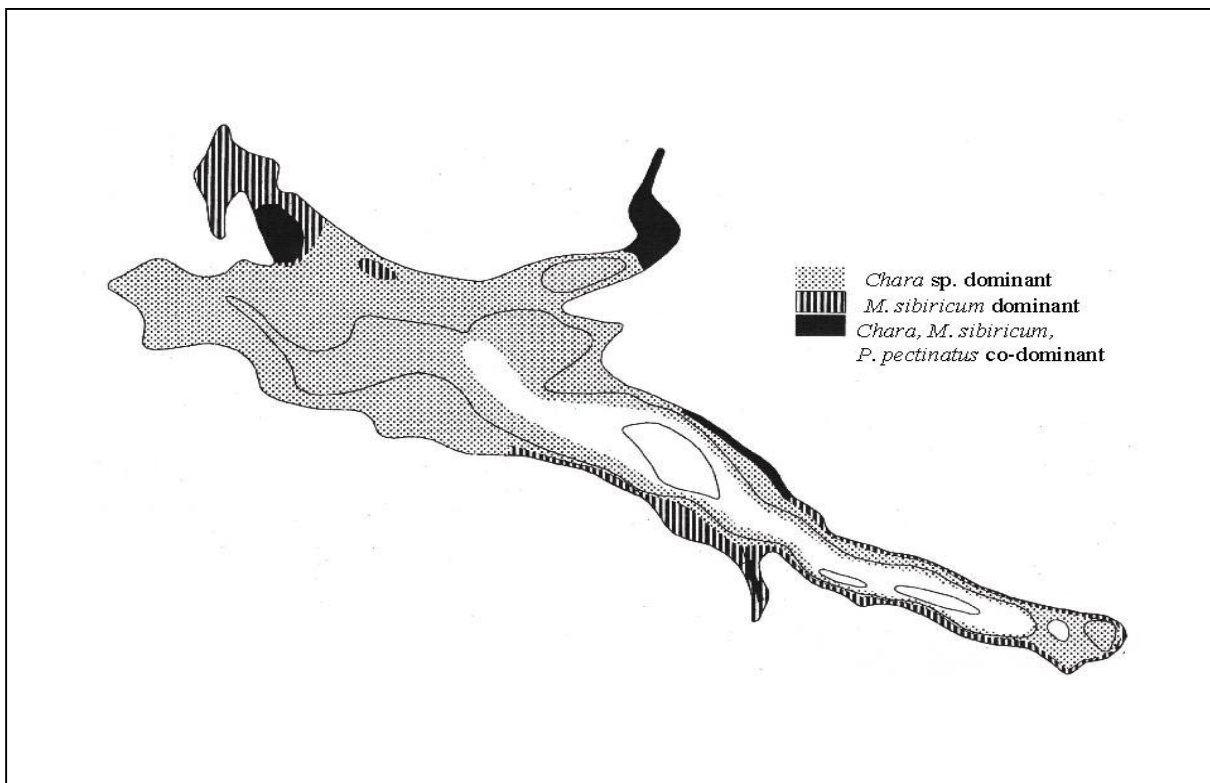


Figure 1. Sample of vegetation map, Quincy Lake, Washington.

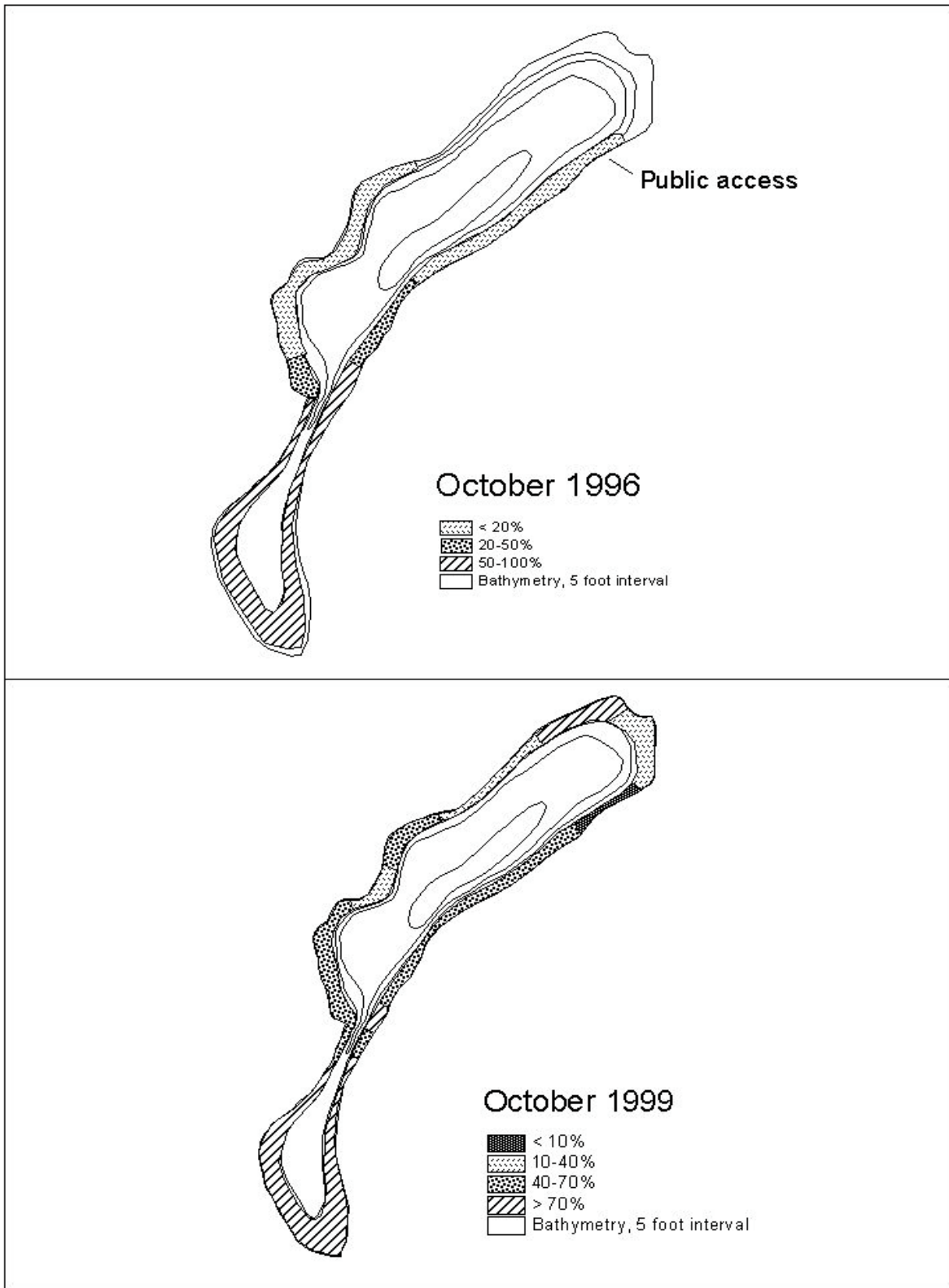


Figure 2. Sample of *Egeria densa* (Brazilian elodea) maps for Leland Lake, Washington. Percentages are percent cover of bottom area.



## Remote Sensing

This method uses photographic equipment from satellites, helicopters, or airplanes. It can be useful for large-scale projects targeting plants at or above the water's surface. It can not be used reliably for submersed vegetation. Our program does not currently use this method. However, since it is a method that tends to spark a lot of interest I have included a few references to recent papers (Marshall and Lee 1994, Kress and Morgan 1995, Caloz and Collet 1997, Muller 1997, Everitt et al. 1999).

## Objective: Quantify a plant population

Obtaining quantitative data is an important part of monitoring plant populations, especially when control methods are being evaluated. One method commonly used in vegetation research is to collect presence/absence data. These can provide good information on the frequency with which a species is found, and also can be used to estimate percent cover (Madsen 1999). The methods described here are fairly simple, and the data can be gathered quickly in the field. The other commonly used means of quantifying aquatic plants is to collect biomass data. These data are generally the most expensive and time consuming to obtain, however biomass data can also provide valuable information on any changes in the plant community. We often use a combination of these methods to obtain a complete picture of what is happening in the plant community. The presence/absence data are useful in telling you if the overall frequency of the target species is reduced, while the biomass data will tell you if the size of the plants present has been reduced. Both methods will indicate changes in species diversity.

## Presence/Absence Methods

Note: Two methods of collecting presence/absence data are described, point-intercept and line-intercept sampling. Both were taken from the more detailed paper by Madsen (1999), please refer to it for additional information. The point-intercept method is generally used to assess species frequency over the whole littoral zone, while line-intercept methods are useful for examining differences between smaller areas such as treatment plots versus control plots.

## Point-Intercept Method

### Required equipment

- ◆ Boat capable of maneuvering in shallow water.
- ◆ Map with pre-selected sampling points.
- ◆ List of the sample point coordinates.
- ◆ GPS unit.
- ◆ Sampling rake and viewing tube.
- ◆ Data sheets for recording the species observed at the sample points.

## Methods

This method utilizes regularly spaced sampling points laid out in a grid pattern throughout the littoral zone. The grid is created before going to the field either with a computerized mapping program or by hand. If a mapping program is used, the point locations should be generated in Universal Transverse Mercator (UTM) coordinates rather than latitude and longitude to facilitate navigation from point to point in the field. The UTM system gives locations in linear measurements (e.g. meters) from set base points located throughout the country. Thus, if your GPS unit is providing steady reliable location information you can quickly determine how far and in which direction you need to travel to reach the next sample point. Because UTM coordinates locate the points by meter intervals, you can select a grid size that is appropriate for the water body. We have used both 30 x 30 meter and 50 x 50 meter grids, depending on the size of the littoral zone (Figure 3). To increase the statistical power it is best to collect as many samples as time will allow, so use the smallest grid practical. If a GPS unit is not available, estimating point location is possible with a detailed map and aerial photographs. However, to avoid bias a GPS unit should be used if possible.

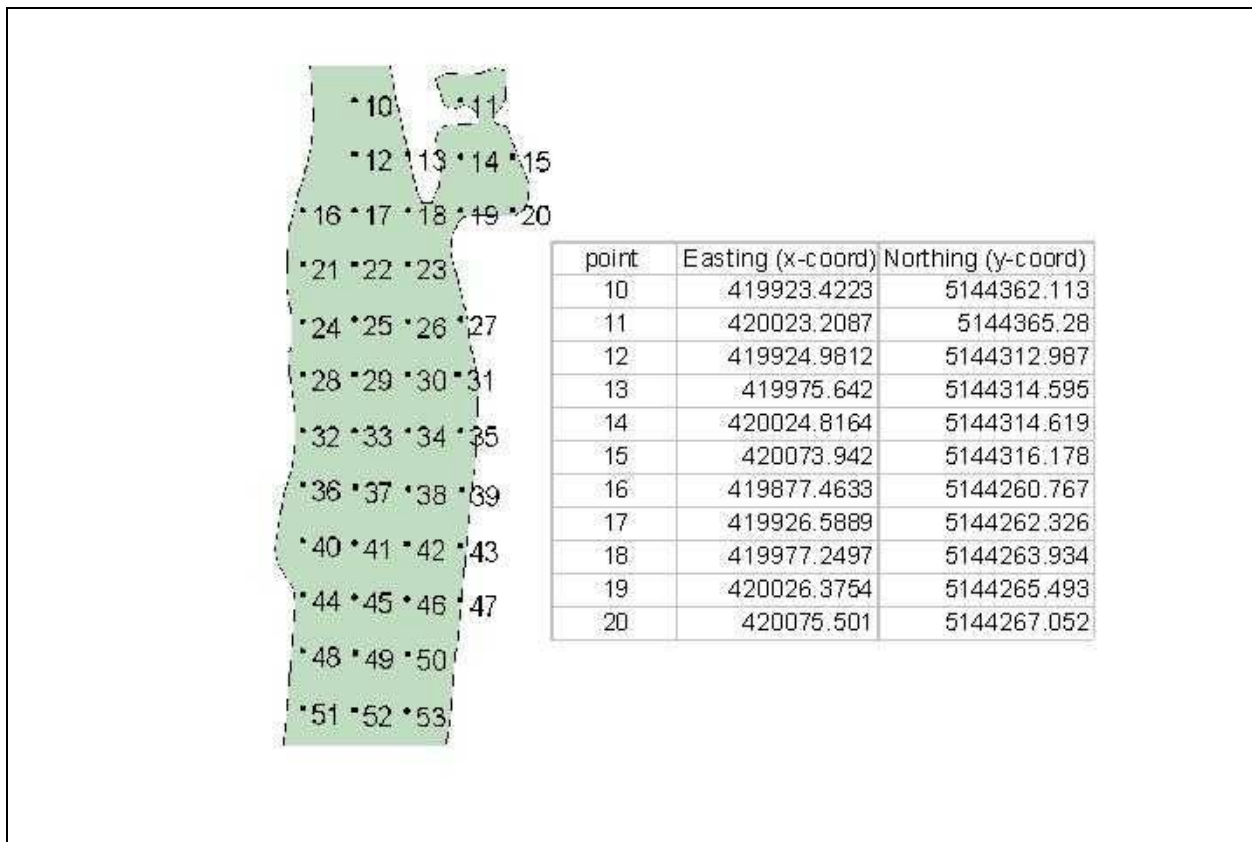


Figure 3. Portion of 50 x 50 meter sample grid for Loomis Lake, Washington with corresponding UTM coordinates.

It is important to use the same sample method at each sample point. If the water is shallow and clear enough to sample with a viewing tube, then select a set area within which to observe the plants (e.g. a 1 m x 1 m square). If using a rake to sample, then try to sample the same area

using the same number of rake tosses each time. For instance we usually record the species collected from two rake tosses on the starboard side of the boat. At each sampling site record all species present in the samples and the depth of the sample on the data sheets, or into a laptop or hand held computer.

We have found it possible to collect about 200 samples per day using this method. Others who use the method more often can collect up to about 300 per day (Madsen, personal communication). As with the other methods described, it is important to collect voucher specimens of each species in the lake. Plant identities can then be verified by taxonomic experts at a later time, and the specimens can be used as reminders the next time the lake is sampled.

### Data Analysis

See Madsen (1999) for details on all the analyses possible with this data (species richness, diversity, frequency, percent cover). If the data were collected once, species frequency can be obtained by dividing the number of points where a species was present by the total number of points. If data are collected two different times or from different locations, they can be compared for changes in species frequency of occurrence over time.

We use this type of data to look at the effectiveness of plant management efforts by comparing before-and-after-treatment species frequency using a Chi square two-by-two analysis with the statistical program Systat® as suggested by Madsen (1999). For this analysis, the data are first entered into a spreadsheet or database program. Each sample point should have presence/absence data for all observed plant species, with present species as a 1 and absent species as a 0. The data analysis program will generate tables listing the number of sampling sites where each species was observed on each date, the percent frequency, and a probability value (p-value) indicating if the difference between the dates is significant (Figure 4). When doing multiple comparisons, we use a Bonferroni correction to adjust the probability value.

	June	August	Total
Absent	15	71	86
Present	75	24	99
Total	90	95	
Test Statistic	Value	df	Prob
Pearson Chi-square	62.6	1.0	0.000

Figure 4. Results from Chi-square analysis on *Myriophyllum spicatum* frequency data collected from Kress Lake, Washington in June and August, 2000. The numbers below the months are the number of samples where *M. spicatum* was observed. The test statistic shows a probability of 0.00, so there was a significant reduction in the frequency with which *M. spicatum* was observed between June and August.

## Line-Intercept Method

### Required equipment

- ◆ Boat capable of maneuvering in shallow water
- ◆ Transect lines marked at 1 meter intervals, with marked flagging every 5 meters. Use a bright colored nylon rope that floats. One hundred meters is a standard length for the line.
- ◆ Weights for securing the sample lines
- ◆ SCUBA diving gear, snorkel gear or viewing tube, depending on the water depth and clarity.
- ◆ Data sheets for recording species observed at the sample intervals

### Methods

This method utilizes data collected along transect lines. Generally the transect lines are laid out perpendicular to shore in the area of interest (e.g. the treatment plots and control (untreated) plots if evaluating the efficacy of invasive species control methods, or at intervals along the shore if assessing the whole lake) (Titus 1993, Madsen 1999). The line may be curved or bent if the littoral zone is too narrow to accommodate the entire length of the line. Careful notes and GPS points should be used to record the location of the lines' end points so they may be relocated for future studies. Collect data along as many transect lines as time will allow to increase the statistical power of the analysis. The recommended number is 400 intervals (4-100 meter transects) per treatment method (Madsen 1999).

To collect the data each transect line is followed by the snorkeler or diver. At each meter interval all species that are intersecting the transect line are recorded as present in that interval. Usually the rope is above the plant bed, so the person collecting the data must envision a plane extending from the line to the sediment. Any plants intersecting that imaginary plane are considered present. It is very helpful to use acetate paper such as Xerox® Never Tear Paper if recording the data while under water.

Note: Titus (1993) recommends recording species presence in quadrats located along transect lines as an alternative sampling method.

### Data Analysis

Data can be analyzed in much the same way as data from the point-intercept method. Please see the discussion under the point-intercept method for details.

We use line-intercept data to assess the effectiveness of plant management efforts in treated versus untreated plots. The Chi-square two-by-two analysis is used as described in the previous section. The pre-treatment and post-treatment plant frequencies in the treated plots and the untreated control plots are compared. The analysis could also be used to compare treated and untreated plots from the same date.

## Biomass Methods

This method yields data on plant mass per unit area (biomass). This is the most time consuming type of data to obtain, but yields valuable information when monitoring the results of aquatic

plant control strategies. The data are usually used to assess changes over time, or to compare different areas at the same time. Care must be used when evaluating the data to account for natural changes in biomass that occur seasonally and variability from year to year. Many methods have been used to collect biomass data. In this paper I only describe what we have used, a complete discussion on biomass techniques can be found in Madsen (1993).

### **Required equipment**

- ◆ Boat capable of maneuvering in shallow water.
- ◆ SCUBA diving gear.
- ◆ List or map with preselected sampling locations.
- ◆ Sample quadrat 0.1 m<sup>2</sup> (we use a PVC pipe frame, it is square with one side missing so the frame can be slipped around the base of the plants. The pipe is left open at the ends so it fills with water and sinks more easily).
- ◆ Transect line marked at 1 meter intervals, or GPS unit for finding sample points.
- ◆ Mesh dive bag to collect plants, use a mesh small enough to contain plant fragments.
- ◆ Plastic sample bags on the boat marked with the sample location information, large enough to hold the samples.
- ◆ Shallow plastic tubs for rinsing and separating the plants by species.
- ◆ Dried and preweighed paper bags for the individual species from each sample site.
- ◆ Drying oven.
- ◆ Scale accurate to 0.01 gram

### **Methods**

The number of samples to be collected and location of sites is determined before going to the field. Madsen (1993) and Spencer and Whitehand (1993) offer suggestions on deciding how many samples will provide statistically meaningful data. We have used a few methods to locate sample sites, generally using a stratified-random approach. Transect lines can be used, and this method is convenient if transect lines are also being used to collect presence/absence data as described earlier in this document. Stratified-random distances along and away from the transect are chosen. For instance, if five samples are to be collected along a 100 m transect, then a random number between 0-19 is selected for the first sample location, another between 20-39 for the second, etc. Then a random number between 0-5 is selected for each sample as the distance off the transect (always off the same side of the transect). Another sample location method is to use a grid similar to that described in the point-intercept frequency method described earlier in this document. Points on the grid are randomly selected and the GPS unit is used to find the sample sites in the field. This method can become stratified if the area to be sampled is divided into sections, and points are chosen randomly from each section. This method can also be used to sample a treatment area if points are only laid out in the treatment plots and control plots.

Before the day of sampling the paper bags should be numbered and dried in the drying oven at a temperature of between 50-70° C. They are then weighed to 0.01 gram accuracy; the weights are recorded on data sheets with the corresponding bag number.

In the field the plant samples are collected at the predetermined locations by a SCUBA diver using the quadrat frame (Madsen 1993) (see Downing and Anderson (1985) for a discussion on the effects of sample quadrat size and number on the results). Plants should be collected in a consistent manner, either keeping or discarding the roots. We have generally found it easiest to collect only the above-sediment parts of the plant. The diver collects the plant material into the mesh bag and transports it to the boat. Support people on the boat transfer the plants from the mesh bag to premarked plastic bags indicating the sample number and location, and any other desired information such as water depth, date, time of day etc.

On shore or back in the lab the samples are washed, sorted by species and placed into the preweighed paper bags. Careful notes need to be maintained with the sample number, bag number and plant species name. Voucher specimens of each species should also be collected independent of the samples and preserved (Appendix B) in case of later questions on the plant's identification.

The bagged plant samples are then dried in the oven at a temperature between 50-70° C. When the plants have dried to a constant weight (usually 24 to 48 hours) the bags are reweighed. The original bag weight is then subtracted from the final weight to give the weight of the dried plants. This number is then divided by the area of the sample frame to obtain the biomass.

### **Data Analysis**

Additional discussion of biomass data analysis can be found in Madsen (1993). We use analysis of variance (ANOVA), but have found it necessary to log transform the data to satisfy the assumption of a normal distribution. It is often useful to group plants if the distribution is very patchy, as is usually the case. For instance, when we were analyzing the effects of an herbicide that targeted dicotyledonous plants, we analyzed effects on native plant species grouped as either dicots or monocots.

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# **Appendix A**

## Plant Identification References

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## **Appendix B**

### Plant Pressing Instructions

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# HOW TO PRESS AND MOUNT AQUATIC PLANTS

## Materials Needed

- Plant press\* - may be purchased or built. It consists of alternate layers of corrugated cardboard and absorbent (blotting) paper or newspaper. It is held on the outside with two equal sized wooden frames or pieces of plywood and straps or some method of applying even pressure (Figure 1).
- Pencil and tablet – for making notes on site.
- Herbarium paper\* - acid-free 100% rag paper is best. If using other paper, use a heavy stock, relatively acid free and with a high rag content such as ‘biology paper’ sold at university bookstores.
- Packets\* - for extra plant structures, use small envelopes or a piece of folded paper (2” x 3”).
- Herbarium paste\* - white glue with a polyvinyl acetate base can be substituted.
- Linen tape – bookbinders tape is best. Cellophane tapes should be avoided.
- Labels\* - Sized to fit in the lower right corner of the herbarium paper (Figure 2).

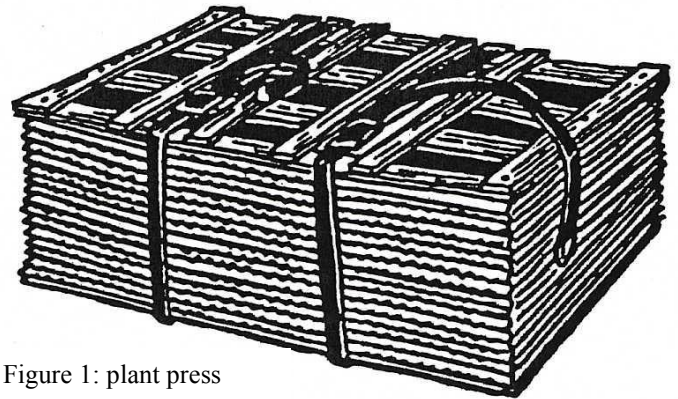


Figure 1: plant press

\* These items are available from biological supply companies such as: Herbarium Supply Co, Carolina Biological Supply Co, Wards Biological Supply.

Washington State  
Department of Ecology Herbarium  
Olympia, WA

plant name → Sparganium eurycarpum Engelm.

site description → PACIFIC COUNTY: T14N R11W S04. Tidal area 5.5 miles south of the Pacific and Grays Harbor County line on Highway 105. Growing in wet soil between drift logs above the beach with Carex obnupta and Oenanthe sarmentosa.

collector → E. Burnett

3 July 1991 ← date

Figure 2: Example of a completed herbarium label

## Collect the Plant:

- Collect as much of the plant as possible; include roots, stems, leaves, flowers and fruits. Plants may be collected by hand pulling, or using a weighted rake in deeper water.
- Write as much information about the plant as possible on the tablet. Include the date, collector’s name, location and name of waterbody, depth of water, flow rate, substrate description, if leaves and flowers are submersed, floating or emergent, color and odor of flowers, names of plant species associated with the collected plant.

- Wash the plant in clean water to remove algae, debris, and sediment. Keep the plants moist until they can be pressed.

### Press the Plant:

Note: It is easiest to identify aquatic plants before pressing. If this is not possible, press the plant while it is fresh, then send it to an aquatic plant expert as instructed below.

Prepare the plants for pressing:

- For delicate submersed plants, the best method is to float the plant directly onto a sheet of herbarium paper. This is accomplished by placing the plant in water with the paper below it. Position the plant on the paper and hold it in place with a finger. Slowly lift the paper plus plant from the water. The water flowing from the paper should separate the leaves while the plant adheres to the wet paper. Cover the plant with wax paper, then sandwich in newspaper or absorbent paper.
- When pressing plants with whorled or finely divided leaves, it is useful to separate a node (the stem section where leaves are attaches) and float that onto a small portion of the paper. This yields a cross section showing the leaf pattern (Figure 3).
- For plants with large bulky stems, roots or leaves, the bulky portion can be split before pressing to facilitate drying, and to prevent uneven pressure in the press.
- If extra flowers, fruits or vegetative parts are collected, these should be pressed, dried, and later placed in the packets. The packets are then glued to the herbarium paper.

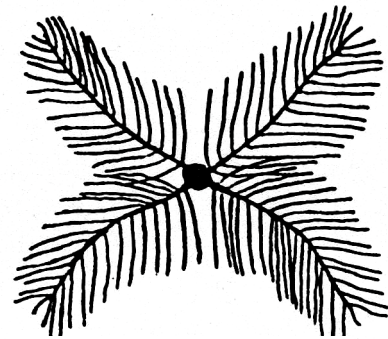


Figure 3: stem cross section

Press the plant material by placing the plant between two sheets of newspaper or absorbent paper then sandwiching this between two sheets of corrugated cardboard. Several prepared specimens can be stacked in this manner (label or number the plants so you know which plants matches which field notes). Place the stack between two firm pieces of wood and apply an even pressure using straps, bolts or a heavy weight. Place this bundle in a warm dry area. To avoid mildew, change the newspaper periodically until the plants are dry. The plants will dry faster if placed over a heat register, fan or incandescent light bulb.

### Mount the Plant:

Note: If identification of the specimen needs to be verified, send a duplicate pressed, but unmounted specimen with a complete label to an authority on aquatic plants. They will keep this specimen for their collection and notify you of the plant's identity.

Once the plant has dried and is identified, it is mounted and kept for future reference

- Arrange the plants on a piece of herbarium paper. If the plant is too long it may be cut into several sections and placed lengthwise on the paper.
- Either glue or tape the specimen to the paper (glue will tend to cause delicate submersed plants to curl, tape may be preferred in such cases).
- Complete a label with the plant's Latin name, location and site description, name of collector and date collected (Figure 2). Adhere the label to the lower right corner of the paper.

- If additional reproductive (seeds, fruits, flowers) or vegetative parts have been collected, these are placed in the packet. This is glued to the herbarium paper so the content may still be accessed.

Care should be taken to ensure that insects do not damage the specimens. Mounted plants should be stored in sealed containers or herbarium cabinets.